RECEIVING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

SPEED REDUCERS

Horizontal-Parallel Shaft

Types

SH and SVR—Single Reduction

DH and DVR—Double Reduction

WESTINGHOUSE ELECTRIC CORPORATION

NUTTALL PLANT • GEARING DIVISION • PITTSBURGH 1, PA.

SUPERSEDES I.L. 1840-A

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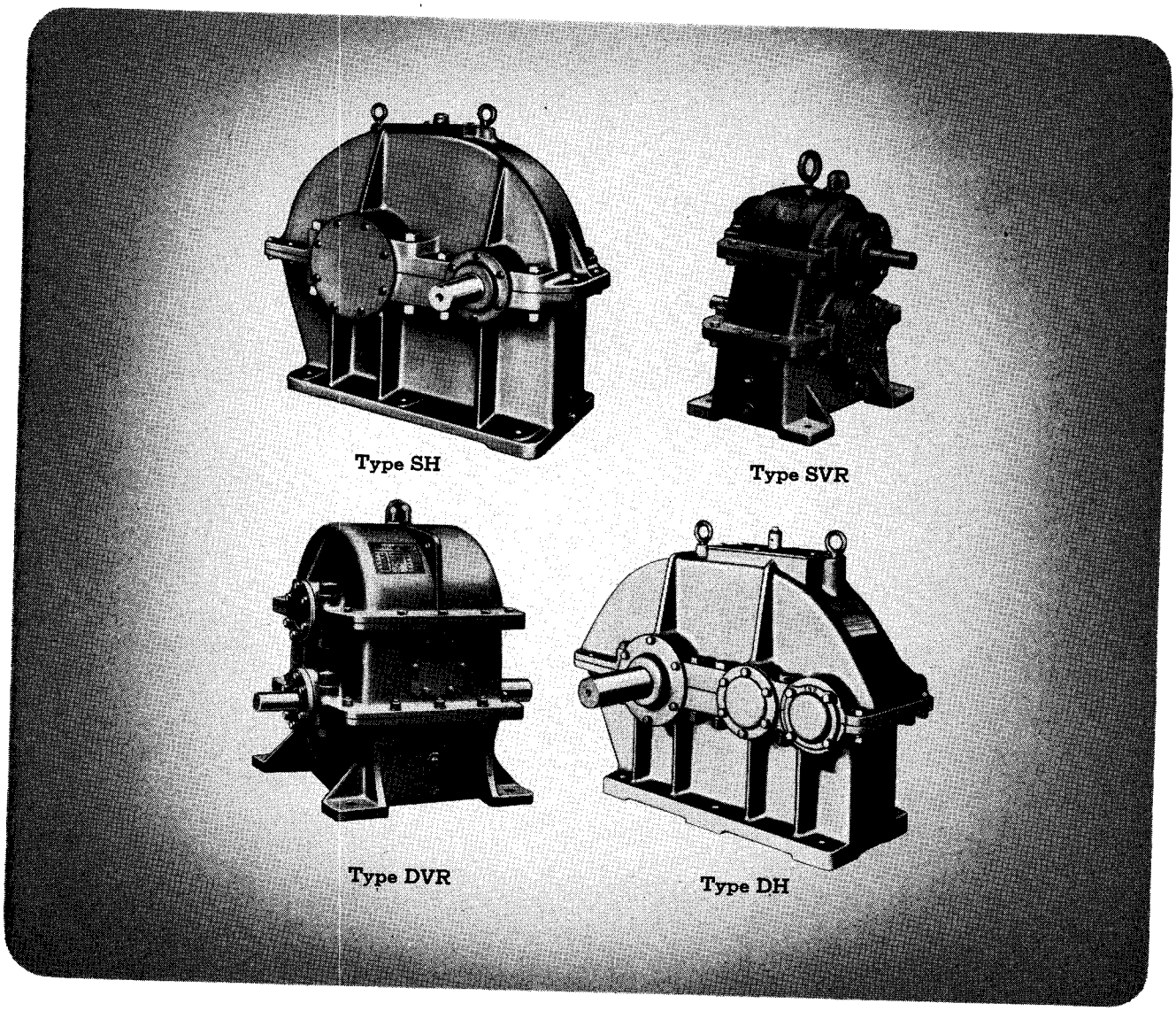


SINGLE REDUCTION

Type SH*—Standard Ratios 2.82:1 to 9.5:1
Type SVR*—Standard Ratios 1:1 to 8.4:1

DOUBLE REDUCTION

Type DH*—Standard Ratios 11.8:1 to 70.5:1
Type DVR*—Standard Ratios 8.14:1 to 46.78:1

*For specific identification and operating ratings, refer to nameplates attached to the speed reducer.

INDUSTRIAL SPEED REDUCERS are designed for use with prime movers such as electric motors, gas, oil or diesel engines. They provide economical transmission of normally high speed motor or engine efficiencies and exact slower speed requirements for driven machines. These units are rated in accordance with the AGMA standards for Helical and Herringbone parallel shaft speed reducers of the industrial type and carry the AGMA nameplate. They are sturdily constructed drives applied to a pre-specified requirement and, properly cared for, should give long and trouble-free service life.

Important: Each drive, as furnished, has been selected to suit the load conditions for the AGMA Service Rating specified on the order. Satisfactory performance of the speed reducer is dependent on adherence to the operational ratings as stated on the nameplates.

RECEIVING AND HANDLING

Immediately upon receipt of the speed reducer, carefully examine the crating, skidding or boxing. If any evidence of damage due to rough handling is apparent, notify the carrier (transportation company) at once, before unpacking the unit.

UNPACKING AND HANDLING

Speed reducers may be packed for shipment in several different ways depending on the size. Larger units and units of medium sizes, when supplied with bedplates and with motors as a complete assembly, are usually mounted on skids only and are adequately braced for car or truck shipments. Smaller units or assemblies may be crated, in which case the bottom of the crate forms a skid. In such cases remove the sides of the crate carefully. The unit in all cases can be moved into convenient position by attaching a tow rope to the skid.

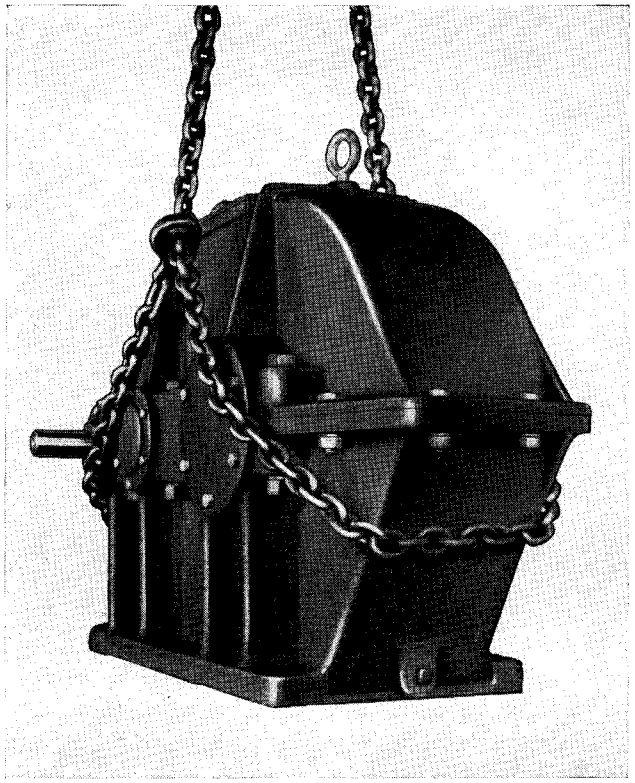


FIG. 1. Correct Method of Hoisting Speed Reducer

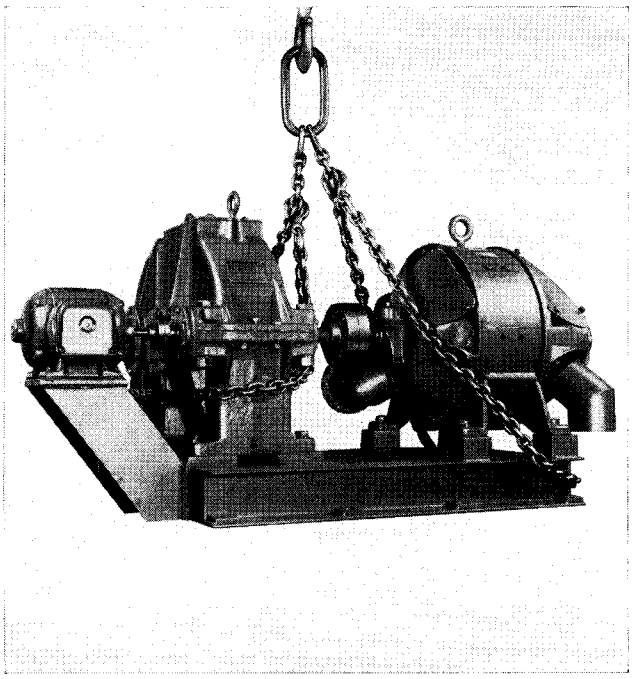


FIG. 2. Correct Method of Hoisting Typical Unit—Bedplate and Motor Assembly

When it is necessary to hoist a speed reducer or an assembly of a motor, speed reducer and bedplate, use the methods illustrated in Figs. 1 and 2 respectively.

Important: Do not attempt to lift these units by any single eyebolt. The eyebolts as provided are intended for use in removing the motor only, or the upper half of gear housing.

Delays in Installation. At times, delays in plant construction or similar conditions may necessitate storing of the unit. The storage location should be dry, clean and as nearly constant in temperature as possible. The speed reducer should be properly filled with oil and turned over manually or by power at least once a week. This procedure will maintain an oil film over the working parts of the gear assembly and prevent corrosion. On larger equipment furnished as an assembly of the motor and speed reducer, the coupling between the motor and the reducer may be disconnected in order to turn over the gear drive manually when power is not available at the storage site.

INSTALLATION

Continuous efficient operation of speed-reducing units depends mainly upon the following factors as covered in this book:

1. Method of mounting and type of foundation.

2. The alignment of the unit with the driven equipment.

3. Type of load and loading conditions.

4. Lubrication.

5. Maintenance.

The speed reducer should be mounted on a solid foundation and properly aligned with the driven equipment. Where the unit is supported on a structural foundation, the thickness of the supporting base plate should not be less than the diameter of the holding down bolts. Sufficient rigidness should be provided in the structural members to prevent sway or flexing. Typical foundation details are shown in "A" and "B" of Fig. 3.

In the majority of installations, the high speed shaft of the speed reducer is directly coupled to the prime mover, while the low speed shaft may be directly coupled to the driven shaft or connected by chain, belt, or pinion mounted on the reducer shaft. Outboard bearings may sometimes be necessary to give proper support to the low speed shaft when this shaft is subjected to unusually heavy loads, as would be in the case when pulleys, sprockets or pinions of small diameters or wide faces are used. When chain or pinion drive is used, it is recommended that the gear unit be doweled to the foundation.

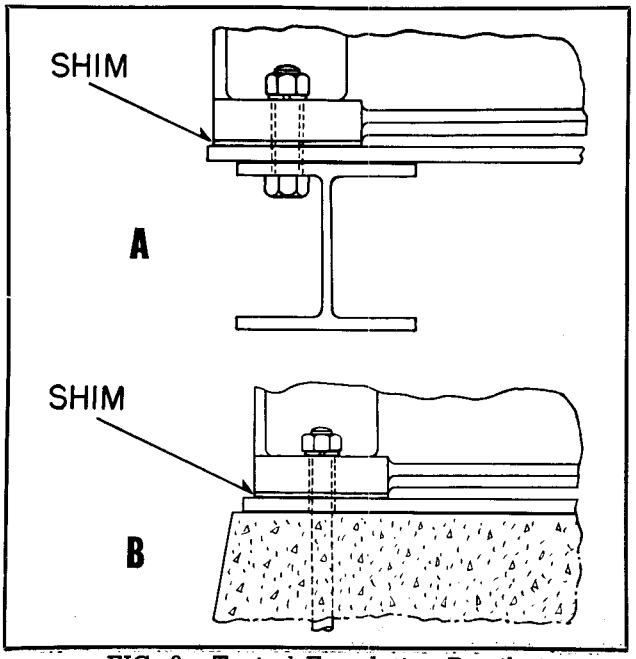


FIG. 3. Typical Foundation Details

For general convenience, the projecting shafts of the speed reducers are made of standard length. This length is often greater than the required width of the sprocket, pinion, etc., used when the units are not coupled to their load. This, however, should not be considered as an invitation to mount the sprocket or pinion at the extreme end of the shaft. Mount them as close to the bearing as possible, as an inch or two of unnecessary overhang may greatly increase the bending stress on the shaft, leading to eventual fatigue failure.

SECURING ALIGNMENT

When the speed reducer is connected to driven equipment by means of a coupling, correct alignment cannot be overemphasized, and becomes of greater importance as speeds are increased or the drive is subjected to variations in load conditions. Misalignment, either parallel or angular, is one of the most frequent causes of bearing or shaft failures, noisy operation, or excessive operating temperatures, due to the extra load thus imposed.

A simple method of checking the installation for parallel and angular alignment is illustrated in Figs. 4 and 5 respectively. A straightedge is laid across the coupling member at the outside diameter and correct parallel alignment is obtained when the straightedge rests on both coupling members for their full length. (See Fig. 4). As a check for correct angular alignment, the use of feeler gauges between coupling member faces is very common practice (See Fig. 5). The taking of such check at four positions on the coupling faces is strongly recommended.

A more accurate coupling alignment check can be made by the use of a dial indicator as shown in Figs. 6 and 7.

For checking parallel alignment, a dial indicator is mounted on a strap which is located on one coupling half, with the dial indicator stem placed on the ***outside diameter of the hub of the opposite coupling half.*** (See Fig. 6). By rotating one coupling half, the amount of misalignment can be read on the dial indicator.

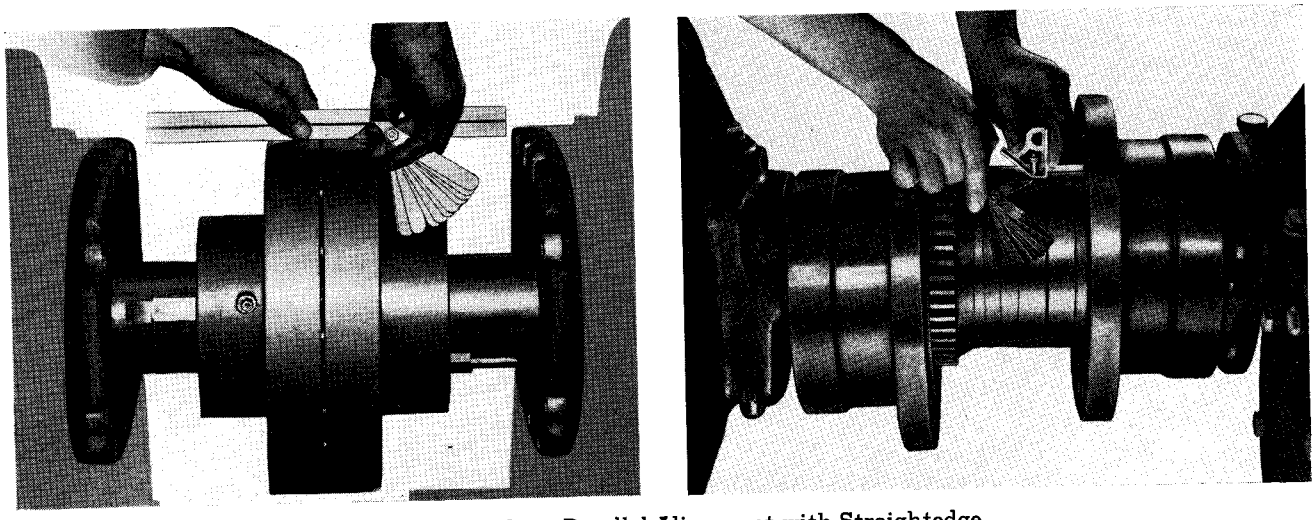


FIG. 4. Checking Parallel Alignment with Straightedge

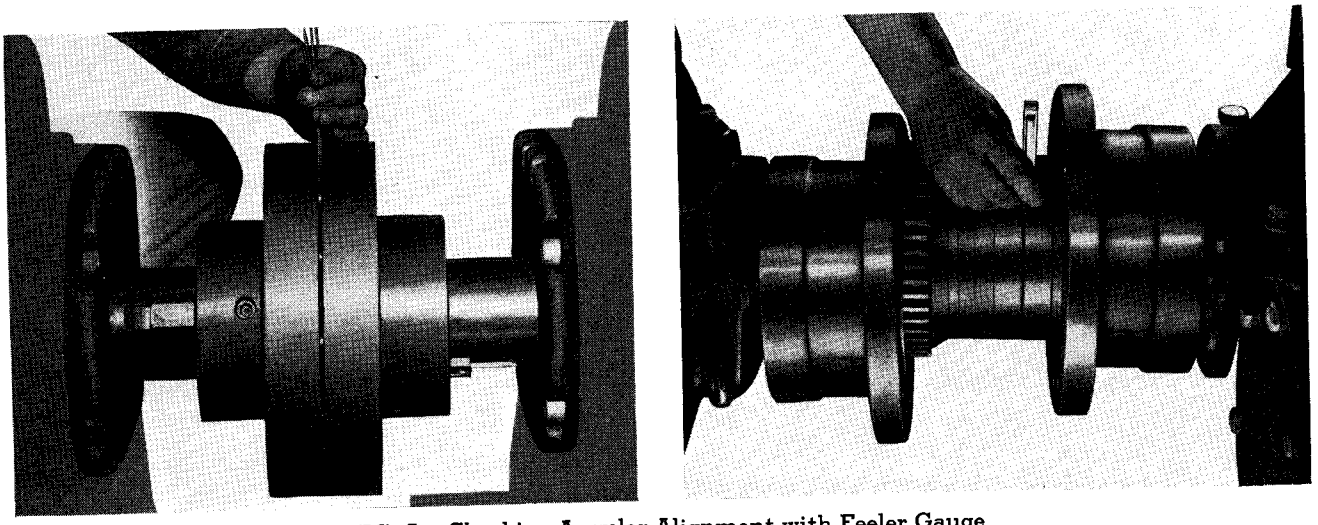


FIG. 5. Checking Angular Alignment with Feeler Gauge

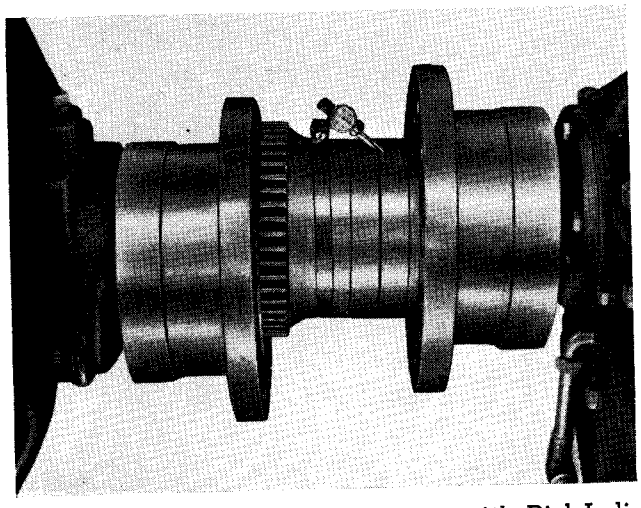


FIG. 6. Checking Parallel Alignment with Dial Indicator on Outside Diameter of Hub

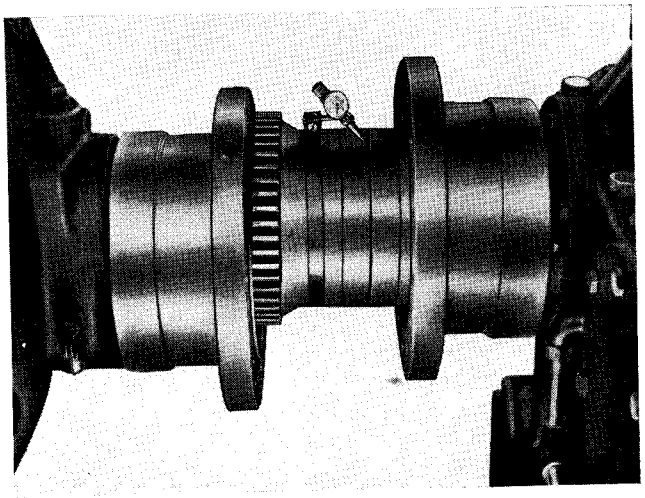


FIG. 7. Checking Angular Alignment with Dial Indicator on Face of Hub

Angular alignment can also be checked with the same indicator set-up by placing the indicator stem on the ***face of the opposite coupling half,*** and then rotating the coupling half carrying the indicator. (See Fig. 7).

PLACING UNIT IN OPERATION

After the unit has been installed, fill the case with oil to the proper oil level indicated, using the recommended grade of lubricant for the particular class of service. (Refer to recommendations given under "Lubrication" and also to the unit nameplate.) Run the unit with a relatively light load for approximately one-half hour, or until the oil has had a chance to collect in the reservoirs at the bearings. Re-check the oil level after the unit has been stopped for approximately ten minutes. This is essential in order to let the oil settle at an even level in the two separate reservoirs. (The main reservoir and the settling chamber at the high speed end are connected by relatively small holes which necessitates a time interval before a correct indication of the oil level is obtained.) As the oil required to fill the bearing reservoirs has lowered the oil level in the case, it may be found necessary to add a small amount of oil to bring the oil level to its indicated position.

If the above procedure is not convenient, oil may be directed into the bearing reservoirs at the same time the oil is poured into the case. By either method, as an extra precaution, the oil level should be re-checked after a few hours of running time.

The oil level indicated applies to the particular ratio furnished with the unit when shipped from the factory. The correct oil level should be such that the smallest gear (not pinion) is dipping in the oil approximately the full depth of the tooth.

Each gear unit is provided with a breather, usually located at the top of the gear case in the hand hole cover. This breather is provided for the specific purpose of reducing the pressure inside the gear case to that of the surrounding atmosphere. If the gear unit is located in a dusty area, the breather should be packed with copper wool to prevent the dust from entering the unit and mixing with the oil.

Important: Never attempt to add or replace oil while the unit is running. Do not fill the unit beyond the indicated oil level. Excess lubricant increases the "churning" effect and will result in overheating with consequent thinning of the oil and possible leakage.

The oil should be drained and filtered (or replaced) approximately one week after it is placed in service, and the unit refilled to the specified level. This practice helps to remove any foreign material which may have collected in the lubricant during initial operation of the unit.

If the gear unit has been furnished as an assembly with couplings of a lubricated type, care should be taken to see that the couplings are lubricated.

LUBRICATION

The areas of contact on gear teeth are relatively small and the pressures produced in transmitting the loads are relatively large. It is, therefore, essential to provide a film of lubricant of sufficient strength to withstand the localized pressure during the period of contact. The peripheral speed of the gear governs the period of tooth contact and determines the time during which the film must withstand the pressures. When speeds are high, the time is short and therefore a comparatively light-bodied lubricating oil can be used. When speeds are low and the loads heavy, the contact time is considerably longer and a heavier-bodied oil should be used. However, the exacting requirements of gear unit lubrication under normal loads demand high grade oils.

Room temperatures or the temperatures of the atmosphere surrounding the gear drive also have considerable bearing on the grade of oil that should be used. Mineral oils invariably show a higher viscosity as the temperature is lowered, and in the majority of instances, a heavy grade of oil possesses a higher pour point than a lighter one refined from the same stock of the same brand unless a special treatment has been used to lower the pour point. Therefore, a gear drive operating in a surrounding temperature of zero (0) to plus 40 degrees Fahrenheit should ordinarily be lubricated with an oil of lower viscosity than the same unit operating in a surrounding temperature of from 41 to 100 degrees.

Westinghouse-Nuttall gear drives are designed with as near fool-proof lubrication systems as possible, wherein the gears and bearings are lubricated with the same oil. It is therefore obvious that if an oil of high viscosity and a high pour point is used in a gear drive which is subjected to low operating temperature, the oil will not readily flow and may result in bearing failures.

The unit should be filled with the recommended grade of oil at the time of installation. For normal operation it is advisable to drain and filter the oil in the gear unit and refill to the specified oil level after one month's initial service, after which changing the oil once every six months will ordinarily be sufficient. Small quantities of oil may be added from time to time to maintain the proper level. However, this is very infrequently required. In no case should the oil level be higher than specified on the oil level nameplate. The oil level should be checked only when the unit is not running.

The maximum temperature (temperature of oil inside the unit) at which a standard unit should be operated is 180 degrees Fahrenheit. For operating temperatures below zero (0) degrees or higher than 180 degrees Fahrenheit, consult Westinghouse engineering personnel.

RECOMMENDED LUBRICANTS FOR TYPES SH, DH, SVR, AND DVR SPEED REDUCERS

Lubricating oils for use in Westinghouse-Nuttall gear drives should be of a high-grade, high-quality, well-refined petroleum oil, filtered and within the recommended viscosity as noted in Table No. 1 and as recommended by the American Gear Manufacturers Association. The trade names of typical oils meeting AGMA recommendations and identified with the AGMA Oil Numbers specified in Table No. 2 are listed in I.L. 7460 instruction leaflet.

Table No. 1
VISCOSITY RANGE, AGMA LUBRICANTS

AGMA LUBRICANT NO.	VISCOSITY RANGE, S.U.V. SECONDS	
	At 100° F.	At 210° F.
2	280 to 360	
3	490 to 700	
4	700 to 1000	
5		80 to 105
6		105 to 125

Table No. 2
LUBRICATION RECOMMENDATIONS

SIZE OF UNITS	AMBIENT TEMPERATURE, DEGREE F.		
	0-40 F. Use AGMA No.	41-100 F. Use AGMA No.	101-150 F. Use AGMA No.
Low Speed Centers Up to 20 Inches	2	4	5
Low Speed Centers Over 20 Inches	3	5	6

Table No. 3
***OIL CAPACITY FOR TYPES SVR AND DVR SPEED REDUCERS**

UNIT NO.	APPROXIMATE OIL CAPACITY	UNIT NO.	APPROXIMATE OIL CAPACITY
SVR-3¾	1 Qt.	DVR-5½	6 Qts.
SVR-5½	4 Qts.	DVR-7	9 Qts.
SVR-7	6 Qts.	DVR-10	3 Gal's.
SVR-10	4½ Gal's.	DVR-13	10 Gal's.
SVR-13	6 Gal's.	DVR-17	12 Gal's.
SVR-17	8 Gal's.		

Table No. 4. *OIL CAPACITY FOR TYPE SH SPEED REDUCERS

UNIT NO.	APPROXIMATE QUANTITY OF OIL FOR RESPECTIVE RATIO RANGE		
SH-6 SH-8	5 Pints for Ratios 9.5 through 2.82 3 Qts. for Ratios 9.5 through 2.82		
SH-9 SH-10 SH-12 SH-14	5 Pints for Ratios 9.5 through 5.3 1 Gal. for Ratios 9.5 through 5.3 1¾ Gal's. for Ratios 9.5 through 4.73 2½ Gal's. for Ratios 9.5 through 4.73	7 Pints for Ratios 4.73 through 2.82 1½ Gal's. for Ratios 4.73 through 2.82 2½ Gal's. for Ratios 4.25 through 2.82 3¾ Gal's. for Ratios 4.25 through 2.82	
SH-16 SH-18 SH-21 SH-25 SH-32 SH-36	3 Gal's. for 9.5 through 6.88 3½ Gal's. for 9.5 through 5.94 6¼ Gal's. for 9.5 through 5.94 11½ Gal's. for 9.5 through 5.94 18 Gal's. for 9.5 through 5.94 26 Gal's. for 9.5 through 5.94	3¾ Gal's. for 6.4 through 4.25 5¼ Gal's. for 5.3 through 3.84 9 Gal's. for 5.3 through 3.84 15 Gal's. for 5.3 through 3.84 26 Gal's. for 5.3 through 3.84 39 Gal's. for 5.3 through 3.84	5¼ Gal's. for 3.84 through 2.82 7 Gal's. for 3.2 through 2.82 11½ Gal's. for 3.2 through 2.82 19½ Gal's. for 3.2 through 2.82 34 Gal's. for 3.2 through 2.82 51 Gal's. for 3.2 through 2.82

* NOTE: Capacities listed are approximate. Be sure to fill gear unit with oil to level indicated by the oil level nameplate.

Table No. 5. *OIL CAPACITY FOR TYPE DH SPEED REDUCERS

UNIT NO.	APPROXIMATE QUANTITY OF OIL FOR RESPECTIVE RATIO RANGE		
DH-6	7 Pints for Ratios 70.5 through 22.0	1 Gal. for Ratios 21.0 through 11.96	
DH-7	1¼ Gal's. for 70.5 through 27.8	1½ Gal's. for 21.0 through 17.0	1¾ Gal's. for 13.2 through 16.0
DH-9	2¼ Gal's. for 70.5 through 27.8	2½ Gal's. for 24.7 through 16.0	2¾ Gal's. for 13.15 through 11.69
DH-10	3¾ Gal's. for 70.5 through 27.8	4 Gal's. for 24.7 through 16.0	4½ Gal's. for 13.5 through 11.7
DH-12	6½ Gal's. for 70.5 through 27.8	7¼ Gal's. for 24.7 through 11.5	
DH-14	10 Gal's. for 70.5 through 27.8	11 Gal's. for 24.7 through 16.0	12 Gal's. for 13.35 through 11.65
DH-16	14¾ Gal's. for 70.5 through 27.8	16¼ Gal's. for 24.7 through 16.0	17½ Gal's. for 13.15 through 11.5
DH-18	20½ Gal's. for 70.5 through 27.8	22½ Gal's. for 24.7 through 16.0	24½ Gal's. for 13.4 through 11.7
DH-20	28 Gal's. for 70.5 through 27.8	31 Gal's. for 24.7 through 16.0	35 Gal's. for 13.5 through 11.7
DH-24	47 Gal's. for 70.5 through 27.8	52 Gal's. for 24.7 through 16.0	58 Gal's. for 13.25 through 11.5
DH-28	80 Gal's. for 70.5 through 27.8	90 Gal's. for 24.7 through 16.0	99 Gal's. for 13.5 through 11.6
DH-36	163 Gal's. for 70.5 through 27.8	178 Gal's. for 24.7 through 16.0	190 Gal's. for 13.15 through 11.5

*NOTE: Capacities listed are approximate. Be sure to fill gear unit with oil to level indicated by the oil level nameplate.

MAINTENANCE

The care of speed reducers is an important operational function, which should be given every reasonable attention to assure long and efficient service life of the unit. A definite inspection and maintenance program with a schedule based on the check chart, Table No. 6, should be regularly followed. Intervals between inspections should be determined by the existing atmospheric and operating conditions.

Correct alignment and mounting are necessary to prevent undue stresses on the shafts and bearings, and restricted action of flexible couplings. Frequently the cause of failure of bearings, shaft breakage, broken bases, overheating and noisy operation of equipment is that insufficient consideration was given to the alignment and mounting. Therefore, these items should be periodically checked in every maintenance schedule. After the unit has been installed and running for about a week, it is recommended that all bolts and nuts be checked and tightened, if necessary. No matter how tight the bolts and nuts were when the units were assembled, they may be subject to vibration which eventually may make them loose. This tightening operation should be part of the maintenance schedule and checked periodically.

The type of load and method of loading is very important in gear unit maintenance because the unit selected for a given service is intended to be operated at close to its rated horsepower capacity for greater efficiency. Although allowance for a certain amount of overload was made when the units were designed for the anticipated load conditions, they are frequently severely overloaded after installation due to excessive unexpected fluctuations in load, or in various parts of the entire installation.

It is important to check the breather at regular intervals to make sure that the breather holes are not clogged with dust and dirt. If the breather has been packed with braided copper wool, this should be cleaned in kerosene or gasoline at frequent intervals.

Maintenance recommendations for oil in the speed reducer are included under "Lubrication", page 6.

CHANGE OF GEAR RATIO

At times it may be desirable to change the output speed. This can generally be done within a certain range by changing the mating gear and pinion either on the high speed or low speed gear set, or both, depending on the output speed required and whether the unit is a single or double reduction type.

Gears and pinions are usually cut on their shafts to insure smooth running. If a gear and

pinion are located on the same shaft, as is usually the case on the intermediate shaft of a double reduction unit, it is recommended that the gear and pinion be purchased as an assembly and not separately.

To install new gears, remove the top half of the gear case by removing all bolts at the flange of the gear case and all bolts holding the bearing end caps to the gear case; also loosen the dowel pins used for locating the upper and lower halves of the gear case. The top half of the gear case may then be lifted. The gears are then exposed and can readily be taken out and replaced.

Particular attention should be given to the adjustment of the shaft end-float. A shim pack is provided at each bearing for bearing clearance or shaft end-float. See Fig. 8.

A shim pack generally consists of:

1—Seigelite Gasket, 1/64-inch thickness

1—Metal shim, .020-inch thickness

3—Metal shims, .007-inch thickness

3—Metal shims, .005-inch thickness

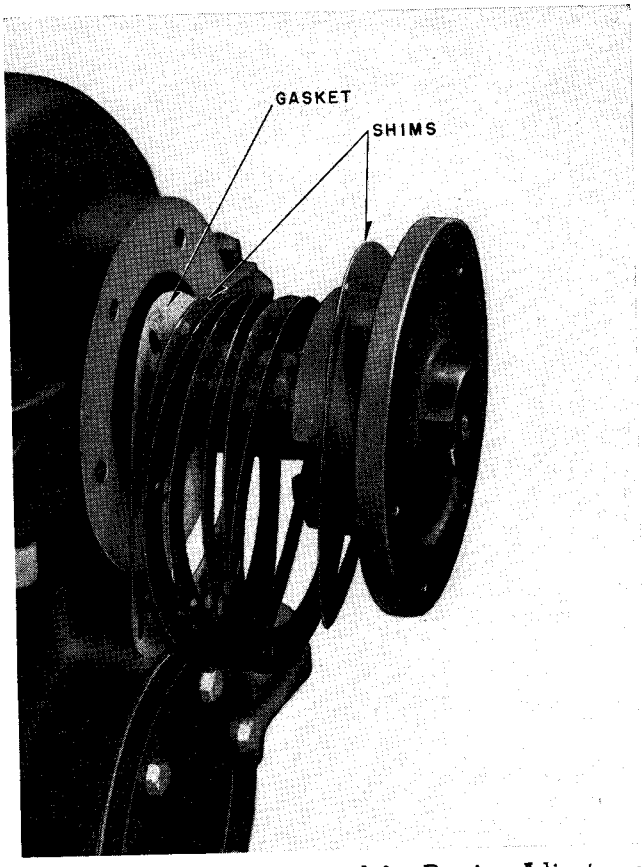
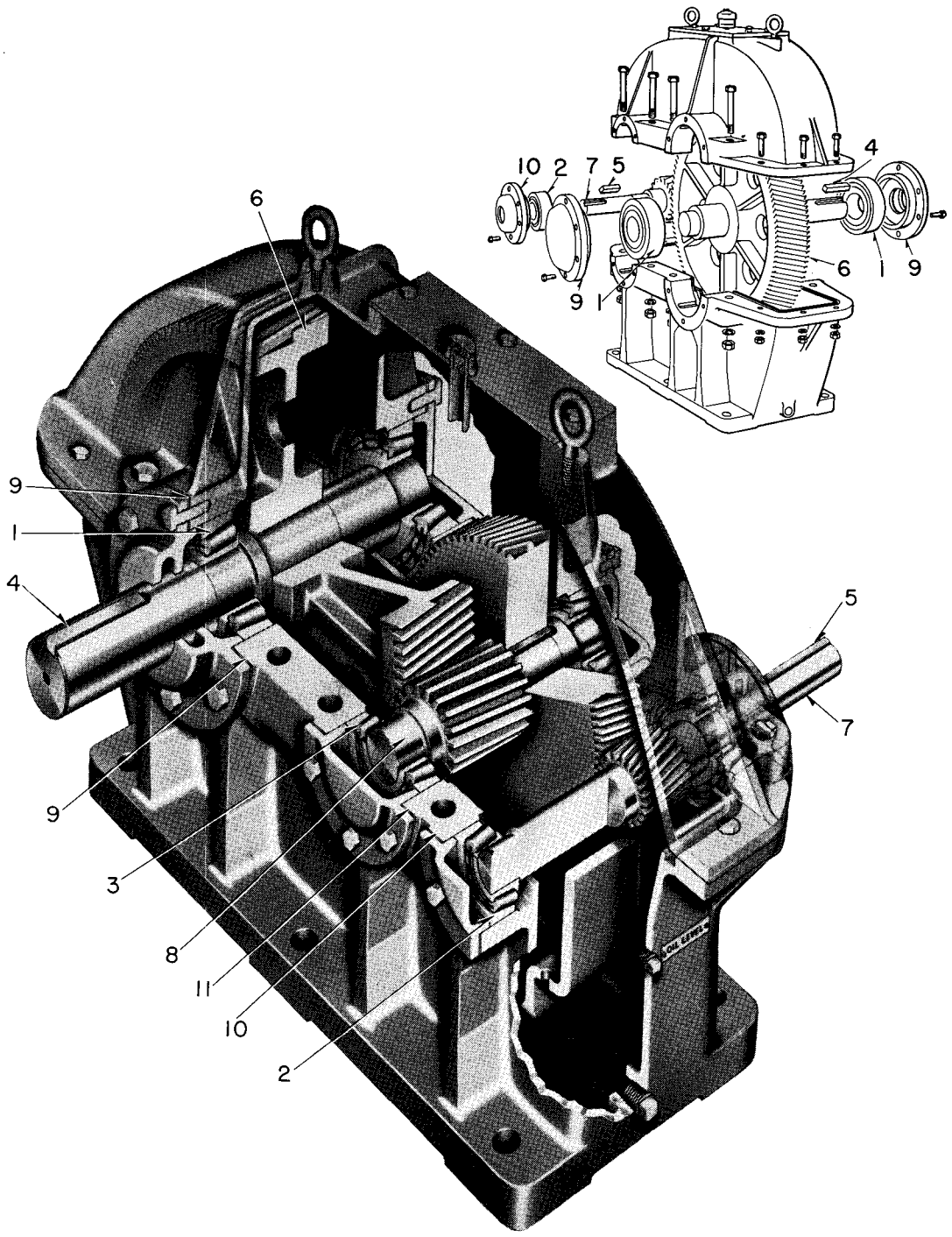


FIG. 8. Shim Pack Arranged for Bearing Adjustment

Table No. 6. OPERATING MAINTENANCE CHECK CHART—SPEED REDUCERS

TROUBLE	PROBABLE CAUSE	CORRECTION
Noisy operation of the unit	1. Misalignment. 2. Faulty lubrication. 3. Excessive tension (if power take-off is by belt or chain drive). 4. Excessive overhung load or vibration caused by inaccurately manufactured parts (if power take-off is by auxiliary gear set). 5. Worn parts caused by normal length of service, or possibly a result of conditions (1), (2), (3) or (4) above. 6. Overloading.	1. Check alignment of unit with driven member. Check condition of couplings, if used. 2. Check oil level. Determine if lubricant is of grade recommended. 3. Check tension and alignment of drive auxiliaries; relieve if necessary. (See that driving pulley or sprocket is mounted as close to the unit as possible.) 4. Check size of overhung pinion to make sure specified overhung load capacity of unit has not been exceeded. Check both pinion and gear of auxiliary set for eccentricity, tooth spacing, tooth contact and even distribution of load across tooth faces. 5. Adjust or replace worn parts. Refer to Speed Reducer Replacement Parts, page 11, for parts identification.
Excessive operating temperature	1. Incorrect lubricant. 2. Incorrect amount of lubricant. 3. Overloading.	1. Check oil against specification instructions. 2. If check shows low oil level, fill to level indicated by nameplate. Drain a portion if level is too high. See that breather is clean and functioning correctly.
Oil leakage	1. Too much oil in unit. 2. Clogged breather. 3. Loose bolts or nuts.	1. Re-check oil level with unit shut down. 2. Remove and clean breather. 3. Re-cement and tighten all joint and end cap bolts.
Loosened mounting bolts	1. Usually vibration from fluctuating loads or misalignment.	1. Check and re-align system. Tighten all bolts.



1. LOW-SPEED BEARING
2. HIGH-SPEED BEARING
3. INTERMEDIATE BEARING
4. LOW-SPEED KEY
5. HIGH-SPEED KEY
6. LOW-SPEED GEAR & SHAFT ASSEMBLY
7. HIGH-SPEED PINION SHAFT
8. INTERMEDIATE PINION SHAFT & HIGH-SPEED GEAR ASSEMBLY
9. LOW-SPEED SHIMS
10. HIGH-SPEED SHIMS
11. INTERMEDIATE SHIMS

FIG. 9. Cutaway View of Double Reduction Speed Reducer Type DH, and Outline Sketch of Single Reduction Unit Type SH

This shim pack equals approximately .070-inch total thickness and allows for the variation in length of the tapered roller bearings and also permits adjustment of the internal bearing clearance to the desired values.

The space between the bearing and the pilot fit of the end cap should be held to a minimum. The clearance at this point should be approximately .002 to .004 of an inch. This can readily be adjusted by proper shimming. All adjustments should be made with the bearing end caps secured tightly against the lower half gear case bearing hubs.

Before the upper half of the gear case and the end caps are assembled, all machined surfaces should be thoroughly cleaned and free from oily substances. A thin coat of a good grade of oil-resisting cement such as Westinghouse No. 5086 or equivalent should be painted on the surfaces at the split of the case, the machined surfaces of the end caps, and the mating surfaces of the gear case. The surfaces should be bolted together before the cement has dried. Particular care should be taken that no cement gets into the bearings.

Important: When the gear ratio of a unit has been changed, it is necessary that the oil level be changed for the new ratio. Make sure that the new nameplate furnished is properly attached to the unit.

SPEED REDUCER REPLACEMENT PARTS

Working parts listed in Table No. 7 are identified by the corresponding numerals in Fig. 9 which illustrates the arrangement of double reduction Type DH speed reducer parts. As the same nomenclature and identification numerals are used for comparable replacement parts in the single reduction Type SH units, a sketch showing the variation in arrangement is included as part of Fig. 9. To avoid possible delay or shutdown when replacement is necessary, it is recommended that a complete set of these parts be maintained in stock.

A complete list of Renewal Parts for Types SH, DH, SVR and DVR speed reducers will be supplied if requested. When ordering, please give complete data which appears on the speed reducer nameplates (see inside front cover of this book) as well as the full name and style number of each part as it appears in the Renewal Parts list.

Table No. 7. COMPONENT PARTS OF TYPES SH AND DH SPEED REDUCERS

IDENTIFICATION AND DESCRIPTION (See Fig. 9)	Type SH SINGLE REDUCTION No. Per Unit	Type DH DOUBLE REDUCTION No. Per Unit
1. Low-Speed Bearing	2	2
2. High-Speed Bearing	2	2
3. Intermediate Bearing	0	2
4. Low-Speed Key	1	1
5. High-Speed Key	1	1
6. Low-Speed Gear and Shaft Assembly	1	1
7. High-Speed Pinion Shaft	1	1
8. Intermediate Pinion Shaft and High-Speed Gear Assembly	0	1
9. Low-Speed Shim Pack	2	2
10. High-Speed Shim Pack	2	2
11. Intermediate Shim Pack	0	2

I.B. 3700-SR-1A

RECEIVING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

SPEED REDUCERS

Horizontal-Parallel Shaft

Types

SHR and SVR—Single Reduction

DHR and DVR—Double Reduction

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NUTTALL PLANT • GEARING DIVISION • PITTSBURGH 1, PA.

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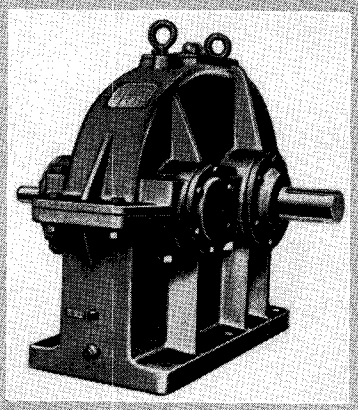
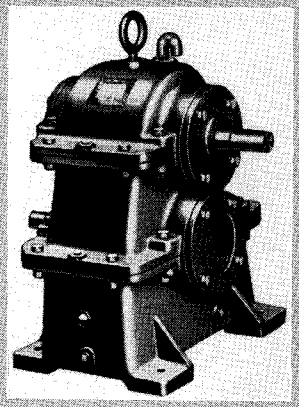
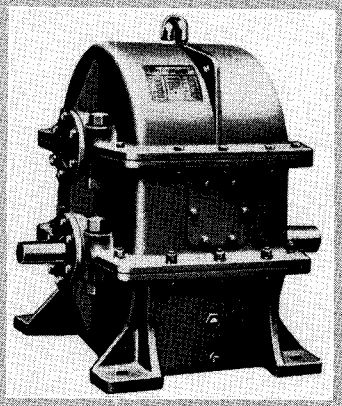


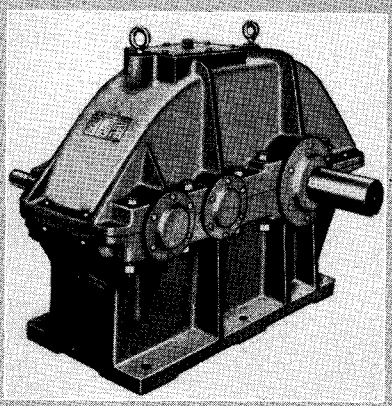
Type SHR



Type SVR



Type DVR



Type DHR

SINGLE REDUCTION	DOUBLE REDUCTION
Type SHR—Standard Ratios 1.84:1 to 9.21:1	Type DHR—Standard Ratios 11.3:1 to 70.0:1
Type SVR*—Standard Ratios 1:1 to 8.4:1	Type DVR*—Standard Ratios 8.14:1 to 46.78:1

*For specific identification and operating ratings, refer to nameplates attached to the speed reducer.

INDUSTRIAL SPEED REDUCERS are designed for use with prime movers such as electric motors, gas, oil or diesel engines. They provide efficient, economical transmission of power from high speed motors or engines to the slower speed requirements for driven machines. These units are rated in accordance with the AGMA standards for Helical and Herringbone parallel shaft speed reducers of the industrial type and carry the AGMA nameplate. They are sturdily constructed drives applied to a pre-specified requirement and, properly cared for, should give long and trouble-free service life.

Important: Each drive, as furnished, has been selected to suit the load conditions for the AGMA Service Rating specified on the order. Satisfactory performance of the speed reducer is dependent on adherence to the operational ratings as stated on the nameplates.

RECEIVING AND HANDLING

Immediately upon receipt of the speed reducer, carefully examine the crating, skidding or boxing. If any evidence of damage due to rough handling is apparent, notify the carrier (transportation company) at once, before unpacking the unit.

UNPACKING AND HANDLING

Speed reducers may be packed for shipment in several different ways depending on the size. Larger units and units of medium sizes, when supplied with bedplates and with motors as a complete assembly, are usually mounted on skids only and are adequately braced for car or truck shipments. Smaller units or assemblies may be crated, in which case the bottom of the crate forms a skid. In such cases remove the sides of the crate carefully. The unit in all cases can be moved into convenient position by attaching a tow rope to the skid.

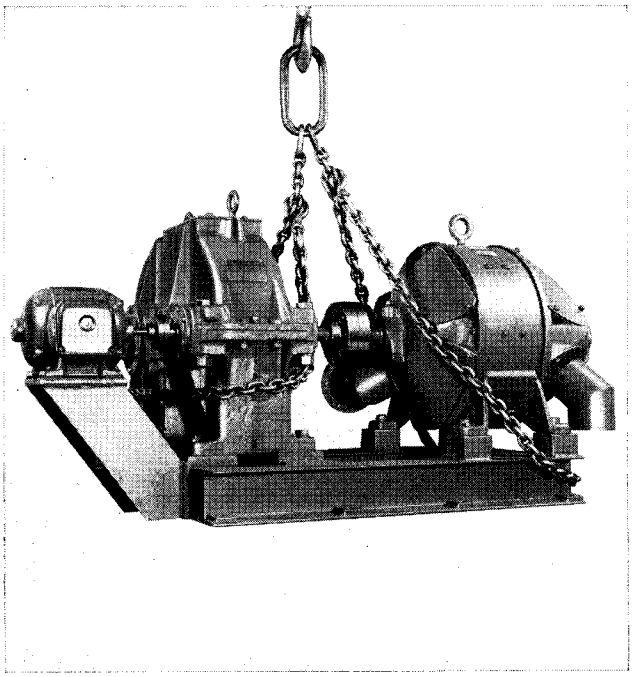


FIG. 2. Correct Method of Hoisting Typical Unit—Bedplate and Motor Assembly

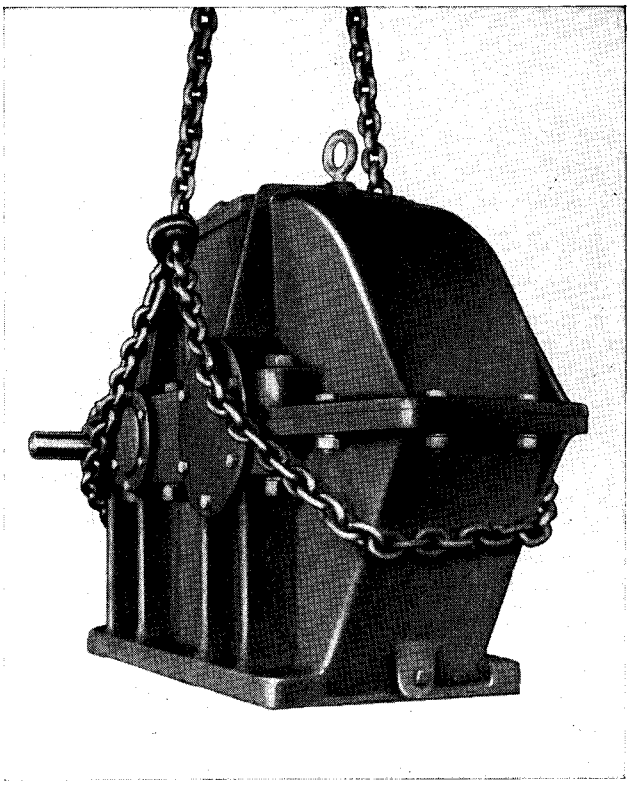


FIG. 1. Correct Method of Hoisting Speed Reducer

When it is necessary to hoist a speed reducer or an assembly of a motor, speed reducer and bedplate, use the methods illustrated in Figs. 1 and 2 respectively.

Important: Do not attempt to lift these units by the eyebolts. The eyebolts as provided are intended for use in removing the motor only, or the upper half of gear housing.

Delays in Installation. At times, delays in plant construction or similar conditions may necessitate storing of the unit. The storage location should be dry, clean and as nearly constant in temperature as possible. The speed reducer should be properly filled with oil and turned over manually or by power at least once a week. This procedure will maintain an oil film over the working parts of the gear assembly and prevent corrosion. On larger equipment furnished as an assembly of the motor and speed reducer, the coupling between the motor and the reducer may be disconnected in order to turn over the gear drive manually when power is not available at the storage site.

INSTALLATION

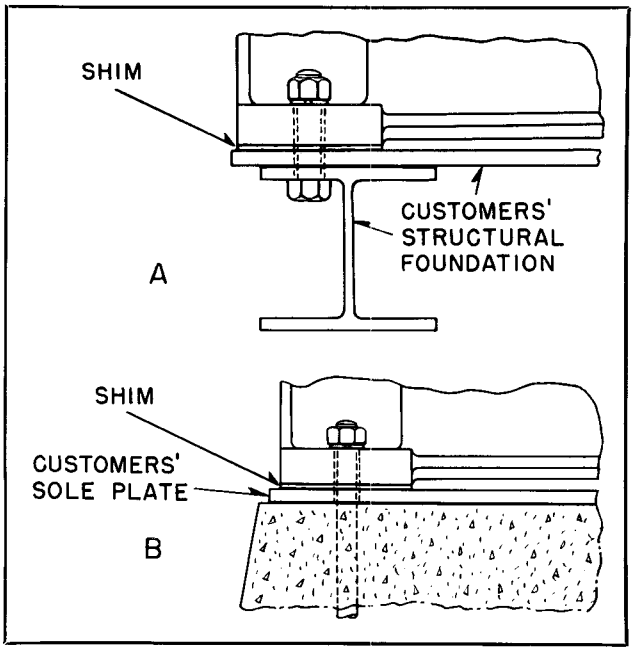


FIG. 3. Typical Foundation Details for Mounting Reducer

Continuous efficient operation of speed reducing units depends mainly upon the following factors as covered in this book:

1. Method of mounting and type of foundation.

2. The alignment of the unit with the driven equipment.

3. Type of load and loading conditions.

4. Lubrication.

5. Maintenance.

SPEED REDUCER WITHOUT BEDPLATE

The speed reducer should be mounted on a concrete or structural steel foundation. Where the unit is supported on a structural foundation, the thickness of the supports under the unit mounting pads should not be less than the diameter of the hold-down bolts. Sufficient rigidness should be provided in the structural members to prevent sway or flexing. Typical foundation details are shown in "A" and "B" of Fig.3.

In the majority of installations, the input shaft of the speed reducer is coupled directly to the prime mover, while the output may be coupled directly to the driven shaft or connected by chain, belt, or pinion to the driven machine.

Following is the recommended procedure for proper installation:

1. Bring the unit to the desired horizontal position by the use of broad flat shims. Do not use wedges

The shimming should also bring the unit into a substantially level position. By removing the inspection cover and laying a spirit level on the machined surface, the levelness of the unit can be checked length wise and cross wise and shimming corrected if necessary.

The area around the inspection opening should be cleaned before removing the inspection cover and care should be taken that no foreign matter be allowed to fall into the opening after the cover is removed. Replace inspection cover immediately after completing this check.

If the reducer does not have an inspection surface parallel with the base (such as SVR and DVR units), extend the shims beyond the reducer feet and check across the top of the shims with a spirit level.

NOTE: Shim thickness should be carefully adjusted under each foot. Do not attempt to compensate for insufficient shimming by pulling down on the foundation bolts. This practice could distort the case, causing improper tooth contact or may result in a cracked casting.

ALIGNMENT

Coupling Connection. Position reducer so that the gap between coupling hubs is in accordance with the coupling manufacturer's recommendation.

In cases where a shaft is free to float axially, the shaft should be marked to show the total amount of axial travel. Set coupling gap when the shaft is in the mid-point of travel.

Motors having floating shafts should be run independently, if possible, and the shaft marked so that the coupling gap can be set with the shaft located in the running position.

For alignment of coupling, see section "Coupling Alignment".

CONNECTION BY OVERHUNG, PULLEY, SPROCKET OR PINION

In the case of overhung pulley or sprocket connection, the reducer shaft must be parallel to the driven shaft in both the vertical and horizontal planes, otherwise, the belt or chain will not run in a central position.

After mounting the chain or belt drive, swing the reducer until the belt or chain runs in a central position. If the driven shaft is not level, it may be necessary to change the shimming under the reducer to obtain a suitable operating position.

For overhung pinion drive locate the reducer in relation to the driven gear by inserting feelers between the pinion and gear teeth. The thickness of the feelers should equal the recommended backlash. Blue three of more pinion teeth and revolve the pinion slowly to check the tooth marking. Make necessary changes to reducer position until a good tooth marking is obtained. An ideal marking should extend across the full gear face but if it is not possible to obtain this condition, the heaviest tooth bearing should be adjacent to the reducer and not toward the end of the shaft.

NOTE: Overhung sprockets, sheaves, pulleys and pinions should be mounted as closely as possible to the reducer end cap to avoid excessive loading on the low speed shaft. Offset hubs should be mounted with the off-set portion toward the end of the shaft.

Belt or chain tension should be kept to the minimum recommended by the manufacturer and in the case of multi-grooved V-belt sheaves the shortest belts of the "matched-set" should be mounted on the reducer side of the sheave.

Outboard Bearings. Outboard bearings should be carefully aligned after the reducer has been finally located and bolted in place. The outboard bearing should be positioned so that it will share the load with the two reducer bearings. Inaccurate shimming of this bearing can defeat its purpose by inducing a load on the shaft and reducer.

ALIGNMENT OF BEDPLATE, REDUCER AND MOTOR ASSEMBLY

When reducer and motor are supplied assembled on a bedplate, the procedure for installation is essentially the same as that shown for speed reducers. Typical foundation details are shown in "C" and "D", Fig. 3A.

Initially, the bedplate should be shimmed to bring the reducer output shaft to the desired height and the reducer into a substantially level position. Shims should be broad and flat and placed as close to the foundation bolts as possible.

Align the reducer output shaft with the driven shaft as described under "Alignment". Change shimming under the bedplate as required to obtain alignment.

Care should be taken when adjusting shim thickness as it is possible to distort the reducer casing by pulling down on a foundation bolt to compensate for inadequate shimming. It is recommended that the motor and reducer bolting and dowels be loosened while the bedplate is being bolted in place. Check under each reducer foot with feelers and add shims where indicated.

It is essential that alignment between motor and reducer shafts be checked before placing the drive in operation. The equipment on the bedplate was aligned at our factory but due to bedplates not being absolutely rigid, warping during handling and installation could affect the alignment.

Break coupling between motor and reducer and check alignment in accordance with "Coupling Alignment" section.

If necessary, the motor should be re-aligned by changing the shimming or location of dowels.

Grout may be poured around the bedplate after all foundation bolts are adequately tightened.

Cautions: Never drive a coupling, pulley or gear on the shaft by hammering. An endwise blow may damage the bearings and gears. Heat the part (preferably in oil) and shrink it on the shaft. An application of white lead to the shaft before shrinking on the part will facilitate later removal.

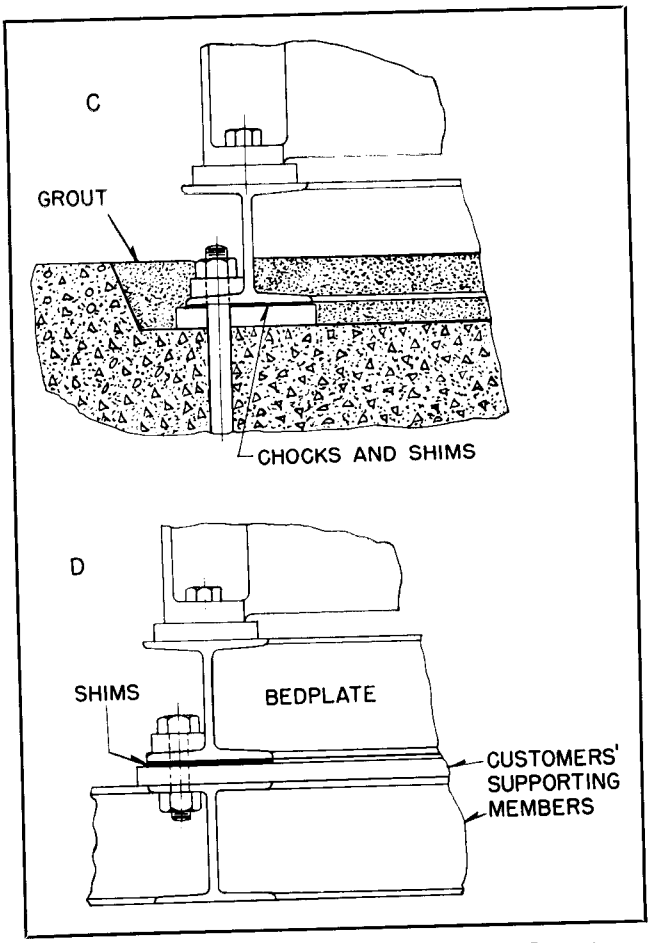


FIG. 3A. Typical Foundation Details for Mounting Reducer—Motor—Bedplate Combination

Do not mount the reducer on ceiling, wall, or an incline or any position other than horizontal unless the reducer was specially designed for such mounting. The lubrication of specially mounted reducers demands careful consideration.

Do not use a wider or smaller diameter pulley, sheave, sprocket, or pinion on the output shaft extension than that for which the reducer was sold. If it becomes necessary to change ratio or increase capacity by using a different overhung member, consult your nearest Westinghouse Representative.

Outboard bearings, when supplied by the purchaser, must be of the expansion type.

COUPLING ALIGNMENT

When the speed reducer is connected to driven equipment by means of a coupling, correct alignment cannot be overemphasized, and becomes of greater importance as speeds are increased or the drive is subjected to variations in load conditions. Misalignment, either parallel or angular, is one of the most frequent causes of bearing or shaft failures, noisy operation, or excessive operating temperatures, due to the extra load thus imposed.

A simple method of checking the installation for parallel and angular alignment is illustrated in Figs. 4 and 5 respectively. A straightedge is laid across the coupling member at the outside diameter and correct parallel alignment is obtained when the straightedge rests on both coupling members for their full length. (See Fig. 4). As a check for correct angular alignment, the use of feeler gauges between coupling member faces is very common practice (See Fig. 5). The taking of such check at four positions on the coupling faces is strongly recommended.

A more accurate coupling alignment check can be made by the use of a dial indicator as shown in Figs. 6 and 7.

For checking parallel alignment, a dial indicator is mounted on a strap which is located on one coupling half, with the dial indicator stem placed on the *outside diameter of the hub of the opposite coupling half.* (See Fig. 6). By rotating one coupling half, the amount of misalignment can be read on the dial indicator.

PLACING UNIT IN OPERATION

After the unit has been installed, fill the case with oil to the proper oil level indicated, using the recommended grade of lubricant for the particular class of service. (Refer to recommendations given under "Lubrication" and also to the unit nameplate.) Run the unit with a relatively light load for approximately one-half hour, or until the oil has had a chance to collect in the reservoirs at the bearings. Re-check the oil level after the unit has been stopped for approximately ten minutes. This is essential in order to let the oil settle at an even level in the two separate reservoirs. (The main reservoir and the settling chamber at the high speed end are connected by relatively small holes which necessitates a time interval before a correct indication of the oil level is obtained.) As the oil required to fill the bearing reservoirs has lowered the oil level in the case, it may be found necessary to add a small amount of oil to bring the oil level to its indicated position.

If the above procedure is not convenient, oil may be directed into the bearing reservoirs at the same time the oil is poured into the case. By either method, as an extra precaution, the oil level should be re-checked after a few hours of running time.

The oil level indicated applies to the particular ratio furnished with the unit when shipped from the factory. The correct oil level should be such that the smallest gear (not pinion) is dipping in the oil approximately the full depth of the tooth.

Each gear unit is provided with a breather, usually located at the top of the gear case in the hand hole cover. This breather is provided for the specific purpose of reducing the pressure inside the gear case to that of the surrounding atmosphere. If the gear unit is located in a dusty area, the breather should be packed with copper wool to prevent the dust from entering the unit and mixing with the oil.

Important: Never attempt to add or replace oil while the unit is running. Do not fill the unit beyond the indicated oil level. Excess lubricant increases the "churning" effect and will result in overheating with consequent thinning of the oil and possible leakage.

The oil should be drained and filtered (or replaced) approximately one week after it is placed in service, and the unit refilled to the specified level. This practice helps to remove any foreign material which may have collected in the lubricant during initial operation of the unit.

If the gear unit has been furnished as an assembly with couplings of a lubricated type, care should be taken to see that the couplings are lubricated.

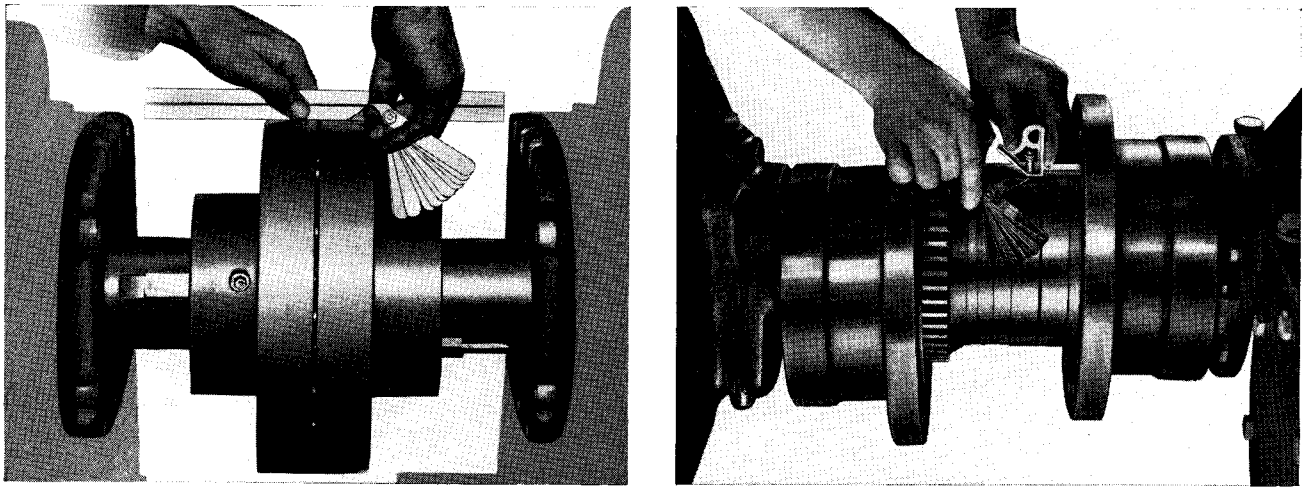


FIG. 4. Checking Parallel Alignment with Straightedge

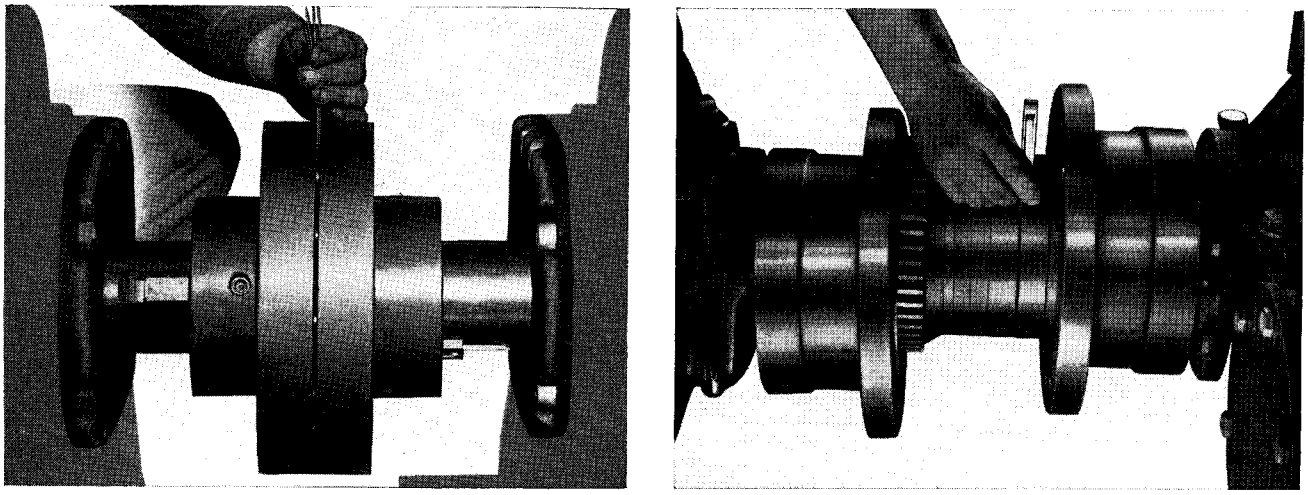


FIG. 5. Checking Angular Alignment with Feeler Gauge

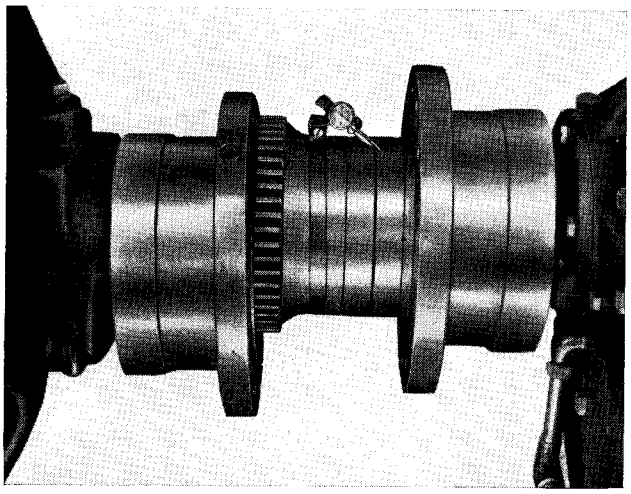


FIG. 6. Checking Parallel Alignment with Dial Indicator on Outside Diameter of Hub

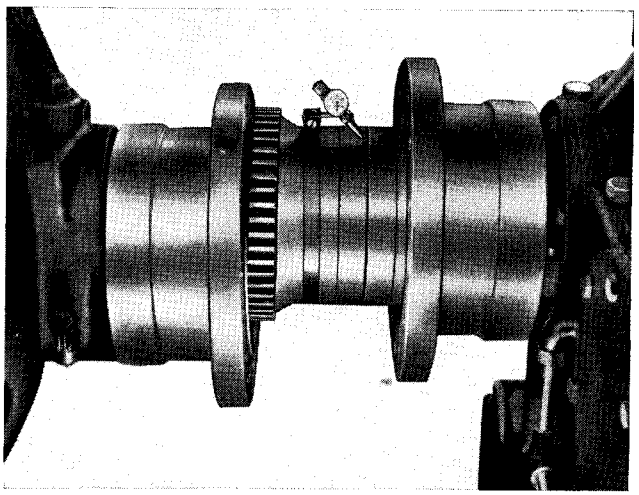


FIG. 7. Checking Angular Alignment with Dial Indicator on Face of Hub

Angular alignment can also be checked with the same indicator set-up by placing the indicator stem on the ***face of the opposite coupling half,*** and then rotating the coupling half carrying the indicator. (See Fig. 7).

LUBRICATION

The areas of contact on gear teeth are relatively small and the pressures produced in transmitting the loads are relatively large. It is, therefore, essential to provide a film of lubricant of sufficient strength to withstand the localized pressure during the period of contact. The peripheral speed of the gear governs the period of tooth contact and determines the time during which the film must withstand the pressures. When speeds are high, the time is short and therefore a comparatively light-bodied lubricating oil can be used. When speeds are low and the loads heavy, the contact time is considerably longer and a heavier-bodied oil should be used. However, the exacting requirements of gear unit lubrication under normal loads demand high grade oils.

Room temperatures or the temperatures of the atmosphere surrounding the gear drive also have considerable bearing on the grade of oil that should be used. Mineral oils invariably show a higher viscosity as the temperature is lowered, and in the majority of instances, a heavy grade of oil possesses a higher pour point than a lighter one refined from the same stock of the same brand unless a special treatment has been used to lower the pour point. Therefore, a gear drive operating in a surrounding temperature of zero (0) to plus 40 degrees Fahrenheit should ordinarily be lubricated with an oil of lower viscosity than the same unit operating in a surrounding temperature of from 41 to 100 degrees.

Westinghouse-Nuttall gear drives are designed with as near fool-proof lubrication systems as possible, wherein the gears and bearings are lubricated with the same oil. It is therefore obvious that if an oil of high viscosity and a high pour point is used in a gear drive which is subjected to low operating temperature, the oil will not readily flow and may result in bearing failures.

The unit should be filled with the recommended grade of oil at the time of installation. For normal operation it is advisable to drain and filter the oil in the gear unit and refill to the specified oil level after one month's initial service, after which changing the oil once every six months will ordinarily be sufficient. Small quantities of oil may be added from time to time to maintain the proper level. However, this is very infrequently required. In no case should the oil level be higher than specified on the oil level nameplate. The oil level should be checked only when the unit is not running.

The maximum temperature (temperature of oil inside the unit) at which a standard unit should be operated is 180 degrees Fahrenheit. For operating temperatures below zero (0) degrees or higher than 180 degrees Fahrenheit, consult Westinghouse engineering personnel.

RECOMMENDED LUBRICANTS FOR TYPES SHR, DHR, SVR, AND DVR SPEED REDUCERS

Lubricating oils for use in Westinghouse-Nuttall gear drives should be of a high-grade, high-quality, well-refined petroleum oil, filtered and within the recommended viscosity as noted in Table No. 1 and as recommended by the American Gear Manufacturers Association. The trade names of typical oils meeting AGMA recommendations and identified with the AGMA Oil Numbers specified in Table No. 2 are listed in I.L. 7460 instruction leaflet.

Table No. 1
VISCOSITY RANGE, AGMA LUBRICANTS

AGMA LUBRICANT NO.	VISCOSITY RANGE, S.U.V. SECONDS	
	At 100° F.	At 210° F.
2	280 to 360	
3	490 to 700	
4	700 to 1000	
5		80 to 105
6		105 to 125

Table No. 2
LUBRICATION RECOMMENDATIONS

SHAFT CENTER DISTANCE*	AMBIENT TEMPERATURE, DEGREE F.		
	0-40 F. Use AGMA No.	41-100 F. Use AGMA No.	101-150 F. Use AGMA No.
Centers Up to 20 Inches	2	4	5
Centers Over 20 Inches	3	5	6

* For Type DHR double reduction units, the low speed gearing center distance should be used. This center distance corresponds to the unit designation number E.G. DHR 14 unit would have approximately 14 inch low speed center distance.

MAINTENANCE

The care of speed reducers is an important operational function, which should be given every reasonable attention to assure long and efficient service life of the unit. A definite inspection and maintenance program with a schedule based on the check chart, Table No. 3, should be regularly followed. Intervals between inspections should be determined by the existing atmospheric and operating conditions.

Correct alignment and mounting are necessary to prevent undue stresses on the shafts and bearings, and restricted action of flexible couplings. Frequently the cause of failure of bearings, shaft breakage, broken bases, overheating and noisy operation of equipment is that insufficient consideration was given to the alignment and mounting. Therefore, these items should be periodically checked in every maintenance schedule. After the unit has been installed and running for about a week, it is recommended that all bolts and nuts be checked and tightened, if necessary. No matter how tight the bolts and nuts were when the units were assembled, they may be subject to vibration which eventually may make them loose. This tightening operation should be part of the maintenance schedule and checked periodically.

The type of load and method of loading is very important in gear unit maintenance because the unit selected for a given service is intended to be operated at close to its rated horsepower capacity for greater efficiency. Although allowance for a certain amount of overload was made when the units were designed for the anticipated load conditions, they are frequently severely overloaded after installation due to excessive unexpected fluctuations in load, or in various parts of the entire installation.

It is important to check the breather at regular intervals to make sure that the breather holes are not clogged with dust and dirt. If the breather has been packed with braided copper wool, this should be cleaned in kerosene or gasoline at frequent intervals.

Maintenance recommendations for oil in the speed reducer are included under "Lubrication", page 8.

CHANGE OF GEAR RATIO

At times it may be desirable to change the output speed. This can generally be done within a certain range by changing the mating gear and pinion either on the high speed or low speed gear set, or both, depending on the output speed required and whether the unit is a single or double reduction type.

Gears and pinions are usually cut on their shafts to insure smooth running. If a gear and pinion are located on the same shaft, as is usually the case on the intermediate shaft of a double reduction unit, it is recommended that the gear and pinion be purchased as an assembly and not separately.

To install new gears, remove the top half of the gear case by removing all bolts at the flange of the gear case and all bolts holding the bearing end caps to the gear case; also loosen the dowel pins used for locating the upper and lower halves of the gear case. The top half of the gear case may then be lifted. The gears are then exposed and can readily be taken out and replaced.

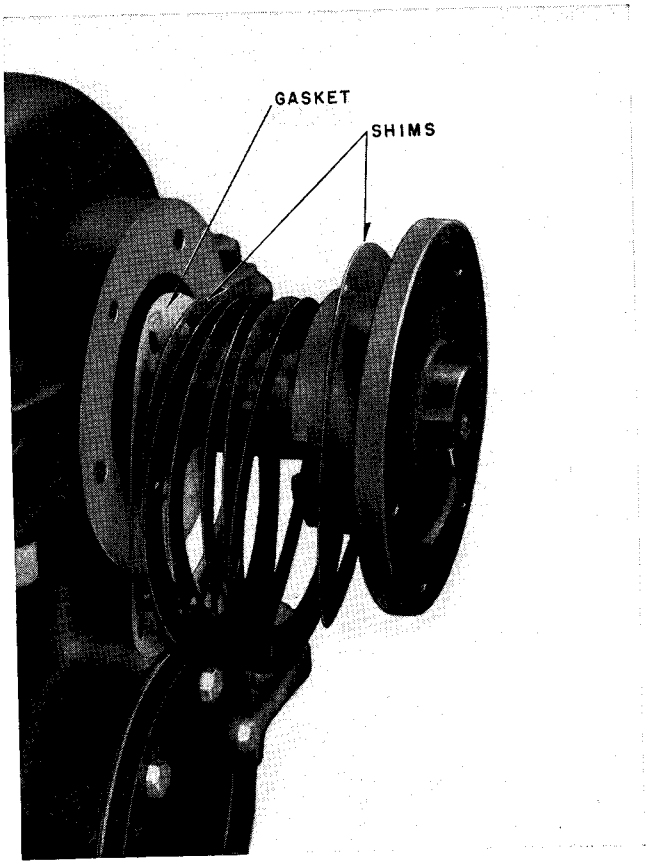
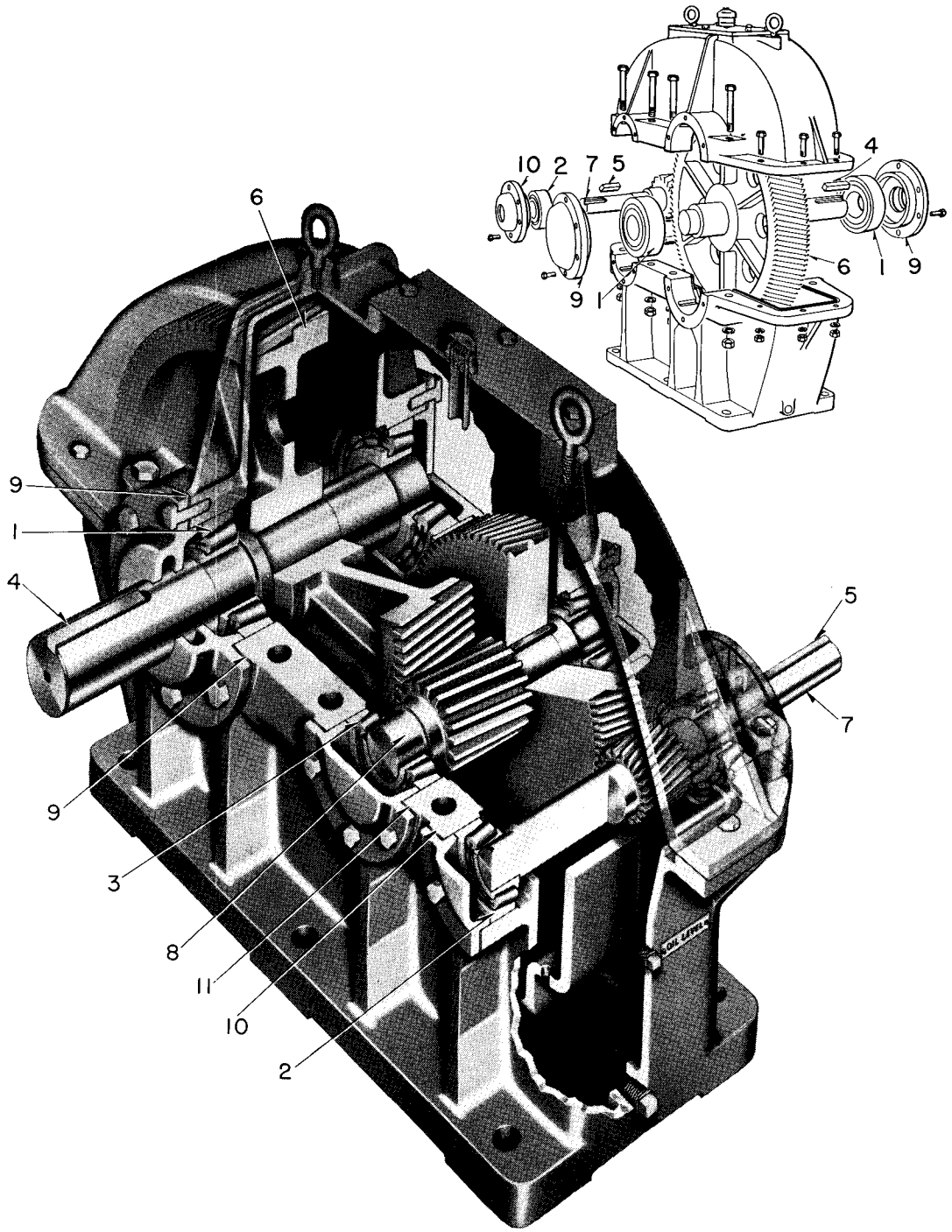


FIG. 8. Shim Pack Arranged for Bearing Adjustment



1. LOW-SPEED BEARING
2. HIGH-SPEED BEARING
3. INTERMEDIATE BEARING
4. LOW-SPEED KEY
5. HIGH-SPEED KEY
6. LOW-SPEED GEAR & SHAFT ASSEMBLY
7. HIGH-SPEED PINION SHAFT
8. INTERMEDIATE PINION SHAFT & HIGH-SPEED GEAR ASSEMBLY
9. LOW-SPEED SHIMS
10. HIGH-SPEED SHIMS
11. INTERMEDIATE SHIMS

FIG. 9. Cutaway View of Double Reduction Speed Reducer Type DHR, and Outline Sketch of Single Reduction Unit Type SHR

Particular attention should be given to the adjustment of the shaft end-float. A shim pack is provided at each bearing for bearing clearance or shaft end-float. See Fig. 8.

A shim pack generally consists of:

1—Seigelite Gasket, 1/64-inch thickness

1—Metal shim, .020-inch thickness

3—Metal shims, .007-inch thickness

3—Metal shims, .005-inch thickness

This shim pack equals approximately .070-inch total thickness and allows for the variation in length of the tapered roller bearings and also permits adjustment of the internal bearing clearance to the desired values.

The space between the bearing and the pilot fit of the end cap should be held to a minimum. The clearance at this point should be approximately .002 to .004 of an inch. This can readily be adjusted by proper shimming. All adjustments should be made with the bearing end caps secured tightly against the lower half gear case bearing hubs.

Before the upper half of the gear case and the end caps are assembled, all machined surfaces should be thoroughly cleaned and free from oily substances. A thin coat of a good grade of oil-resisting cement such as Westinghouse No. 5086 or equivalent should be painted on the surfaces at the split of the case, the machined surfaces of the end caps, and the mating surfaces of the gear case. The surfaces should be bolted together before the cement has dried. Particular care should be taken that no cement gets into the bearings.

Important: When the gear ratio of a unit has been changed, it is necessary that the oil level be changed for the new ratio. Make sure that the new nameplate furnished is properly attached to the unit.

SPEED REDUCER REPLACEMENT PARTS

Working parts listed in Table No. 4 are identified by the corresponding numerals in Fig. 9 which illustrates the arrangement of double reduction Type DHR speed reducer parts. As the same nomenclature and identification numerals are used for comparable replacement parts in the single re-

Table No. 3. OPERATING MAINTENANCE CHECK CHART—SPEED REDUCERS

TROUBLE	PROBABLE CAUSE	CORRECTION
Noisy operation of the unit	1. Misalignment. 2. Faulty lubrication. 3. Excessive tension (if power take-off is by belt or chain drive). 4. Excessive overhung load or vibration caused by inaccurately manufactured parts (if power take-off is by auxiliary gear set). 5. Worn parts caused by normal length of service, or possibly a result of conditions (1), (2), (3) or (4) above. 6. Overloading.	1. Check alignment of unit with driven member. Check condition of couplings, if used. 2. Check oil level. Determine if lubricant is of grade recommended. 3. Check tension and alignment of drive auxiliaries; relieve if necessary. (See that driving pulley or sprocket is mounted as close to the unit as possible.) 4. Check size of overhung pinion to make sure specified overhung load capacity of unit has not been exceeded. Check both pinion and gear of auxiliary set for eccentricity, tooth spacing, tooth contact and even distribution of load across tooth faces. 5. Adjust or replace worn parts. Refer to Speed Reducer Replacement Parts, page 11, for parts identification.
Excessive operating temperature	1. Incorrect lubricant. 2. Incorrect amount of lubricant. 3. Overloading.	1. Check oil against specification instructions. 2. If check shows low oil level, fill to level indicated by nameplate. Drain a portion if level is too high. See that breather is clean and functioning correctly.
Oil leakage	1. Too much oil in unit. 2. Clogged breather. 3. Loose bolts or nuts.	1. Re-check oil level with unit shut down. 2. Remove and clean breather. 3. Re-cement and tighten all joint and end cap bolts.
Loosened mounting bolts	1. Usually vibration from fluctuating loads or misalignment.	1. Check and re-align system. Tighten all bolts.

duction Type SHR units, a sketch showing the variation in arrangement is included as part of Fig. 9. To avoid possible delay or shutdown when replacement is necessary, it is recommended that a complete set of these parts be maintained in stock.

A complete list of Renewal Parts for Types SHR, DHR, SVR and DVR speed reducers will be supplied if requested. When ordering, please give complete data which appears on the speed reducer nameplates (see inside front cover of this book) as well as the full name and style number of each part as it appears in the Renewal Parts list.

Table No. 4. COMPONENT PARTS OF TYPES SHR AND DHR SPEED REDUCERS

IDENTIFICATION AND DESCRIPTION (See Fig. 9)	Type SHR SINGLE REDUCTION No. Per Unit	Type DHR DOUBLE REDUCTION No. Per Unit
1. Low-Speed Bearing	2	2
2. High-Speed Bearing	2	2
3. Intermediate Bearing	0	2
4. Low-Speed Key	1	1
5. High-Speed Key	1	1
6. Low-Speed Gear and Shaft Assembly	1	1
7. High-Speed Pinion Shaft	1	1
8. Intermediate Pinion Shaft and High-Speed Gear Assembly	0	1
9. Low-Speed Shim Pack	2	2
10. High-Speed Shim Pack	2	2
11. Intermediate Shim Pack	0	2